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June 27, 2012

Via Electronic Mail

Ms. Sharon Gillett – Bureau Chief
Wireline Competition Bureau
Federal Communications Commission
445 12th Street, SW
Washington, D.C., 20554

Re: Toll-free Number Exhaust Forecasting/ 844 NPA Announcement
CC Docket No. 95-155

Dear Ms. Gillett,

SMS/800, Inc. recently completed a forecasting assessment of the utilization of toll-free numbers and determined the need to prepare the SMS/800 to support the addition of the 844 Numbering Plan Area (NPA). The forecast is based on a combination of multiple statistical models using data from August 1997 through March 2012.

Following is a snapshot of the toll-free number utilization forecasting assessment:

Percentage of Toll Free Numbers In Use	Toll Free Numbers In Use	Date Reached
85%	33,821,578	3Q2012
90%	35,811,083	3Q2013
95%	37,800,578	3Q2014

I have also attached to this letter a copy of the full forecasting assessment report for your review and will file a copy under Docket 95-155.

The expectation is that SMS/800 will be able to support number reservation and customer record administration activities associated with 844 numbers by 1Q2013.

We are currently preparing for an 844 code opening only. It is my understanding that in the past there have been suggestions that the Commission open multiple codes at one time. If that is your preference for this coming code opening please let me know so that we can modify our current readiness plan.

As the Commission knows, preparation of the SMS/800 to handle testing with 844 numbers is the first step in a chain of activities that includes downloading of 844 records to updated Service Control Points (SCPs), completion of upgrades to support the routing of 844 calls, and testing of the entire network end-to-end.

When it is convenient for you and your team, SMS/800, Inc. would appreciate the opportunity to discuss the following topics relative to the opening of the 844 code:

The criteria for declaring exhaust should be reviewed and defined. For the opening of the 855 code, we used the criteria of having 10% of the total quantity of toll-free numbers remaining in the Spare pool. There are several options for defining 'exhaust' going forward, including continuing with a percentage of the resource, defining a minimum quantity of Spare numbers, etc.

The potential need for a 'rationing' system should be reviewed. If the Commission is considering the implementation of a system for limiting the utilization of toll-free numbers, it would be very helpful to have discussions about this approach to ensure that we are able to respond to the directive.

Please let me know when it would be convenient to discuss the topics mentioned above.

Thank you for your time and consideration.

Very truly yours,

Thomas O. FitzGerald
President & CEO
SMS/800, Inc

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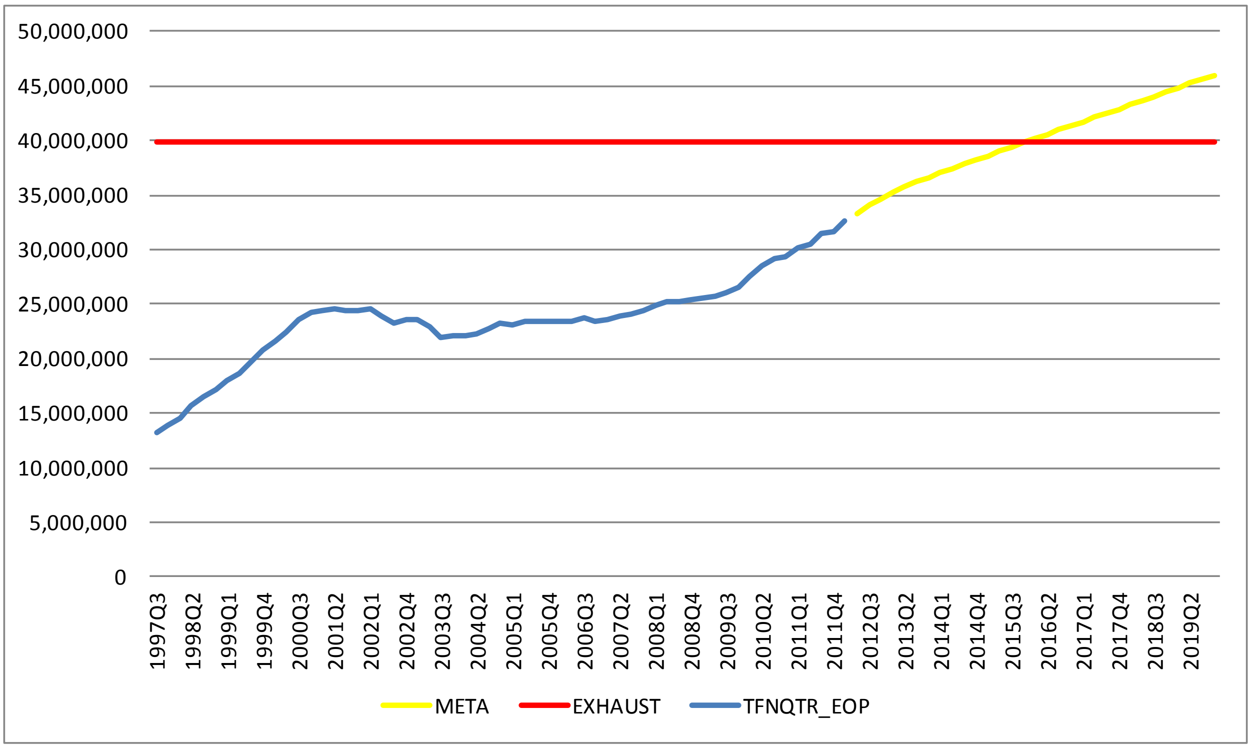
Forecasting Utilization of Toll Free Numbers

May 2012

Executive Summary

In the first quarter of 2008, the prior method of assessing the exhaust date of toll-free number (TFN) capacity was abandoned in favor of using more formal statistical time series forecasting techniques.[1] Most recently, data beginning in August 1997 and running through the end of March 2012 was examined. SMS/800, Inc. considered a variety of candidate statistical models using an approach comparable to that employed in previous studies, the most recent in November 2011. Two models had very similar statistical characteristics, but different estimates of exhaust – these models were combined to form a meta-model. Thus, the choice of the meta-model is consistent with conservative, but statistically supported, decision-making with respect to planning for the next code opening. The meta-model's TFN forecast (in yellow) and the TFN exhaust value (in red) are shown below.



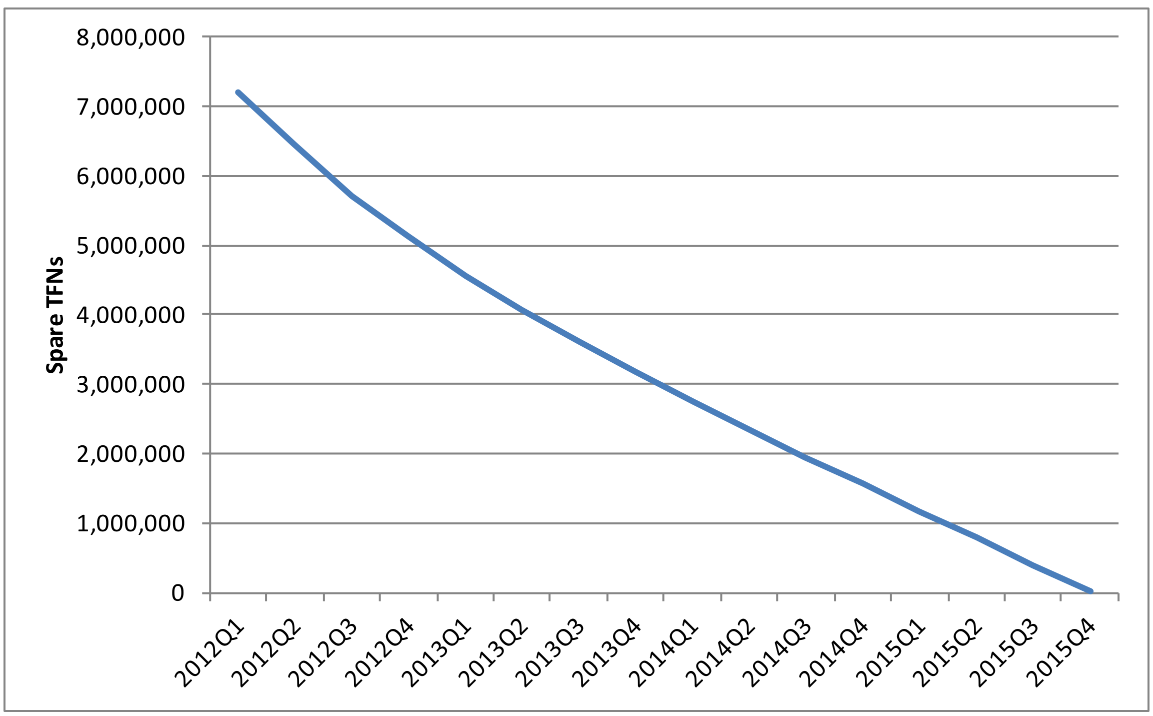
At the end of March 2012, 81% of the TFN pool was in use. While the meta-model forecast predicts exhaust of the currently available TFN pool during the first quarter of 2016, the following table shows the forecasted dates for reaching 85%, 90% and 95% of the current TFN pool.

[1] The old method, used for more than a decade, employed a six-week rolling average of weekly number growth (or decline) and was highly volatile.

% of TFN Pool in Use	TFNs	Date Reached
85%	33,821,578	2012Q3
90%	35,811,083	2013Q3
95%	37,800,587	2014Q3

As the size of the total TFN pool increases, however, the use of such percentages may be misleading as to the amount of TFNs remaining. A better measure may be the percentage *of the equivalent of a new code* that remains available. Prior to the opening of the 855 code in October 2010, 91.5% of the TFN pool was in use, i.e., approximately 2.68 million TFNs were in the spare pool. When examined as a percentage of a new code that has 7.98 million TFNs, those 2.68 million spare TFNs represented 33.6% of that available. In the 18 months since the 855 code opening, an additional 3.53 million TFNs are in use, more than the spare pool at the time 855 was opened. At the end of March 2012, the 7.21 million spare TFNs represented 18.1% of the total TFN pool but 90.4% of a new code.

This information can be viewed in yet another way - by showing a forecast of the stock of *spare* TFNs. As shown in the chart below, the meta-model forecasts that the 7.21 million spare TFNs will exhaust in early 2016.



The business decision facing SMS/800, Inc. is when to start the planning and development effort required to open a new toll-free Numbering Plan Area (NPA). Although forecasting an exhaust date is helpful in that process, it does not adequately convey the degree of risk and uncertainty (whether large or small and inherent in any forecast) as to when exhaust may occur. Thus, SMS/800, Inc.'s forecast methodology also assesses the risk of exhaust at particular dates in the near future.

Based on feedback from SMS/800, the toll-free industry requires 18-24 months to prepare and open a new toll-free NPA, e.g., 844. Of the two models included in the meta-model, the more aggressive model (earlier exhaust date) indicates that the risk of exhausting the current stock of TFNs is:

- Less than 10% through second quarter 2013;
- 20% in fourth quarter 2013; and,
- 25% at the end of first quarter 2014.

Forecast risk occurs because historical data demonstrate that the growth in TFNs is variable and, at times, can accelerate quickly, as occurred during late 2009 and early 2010. While the forecast provides the most likely exhaust date, the forecast risk warns that history has demonstrated that the possibility of earlier exhaust is clearly not negligible. Of all forecasting methods, only a statistical forecast is probabilistic and can estimate such risk. It is important to understand that the risk of exhaust is only 50% at the statistically forecasted exhaust date - i.e., equal odds that TFNs in use will exceed versus fall short of TFNs available. Thus, a one in four chance of exhaust in 2014 represents significant enough risk that in the interim SMS/800 should continue monitoring carefully the TFN stock vis-à-vis the forecasted TFN demand.

The statistical techniques used to develop these projections rely on historical data and thus cannot predict turning points or dramatic changes in growth that are not implicit in the historical data. Thus, the forecasting exercise that SMS/800, Inc. has performed simply describes the most likely date that toll-free number capacity will be reached *if the data patterns of August 1997 through March 2012 should continue into the future*.[2]

SMS/800, Inc. believes that statistical analyses are the most appropriate methods for projecting the exhaust of the TFN pool and assessing the risk surrounding the business decisions. However, the industry has historically relied on a method published by ATIS in the "Toll Free Resource Exhaust Relief Planning Guidelines" (ATIS-0300057, July 1998) to determine when the TFN pool would exhaust and therefore this approach was also examined.

Using monthly and quarterly data, and assessing the results for multiple sample sizes, the predicted exhaust dates vary from October 2014 to March 2016. The approach, analysis and results are examined in more detail in Appendix A.

[2] Time series techniques model only patterns of motion in the data and cannot account for changes in underlying external forces. If forces underlying the motion of the series change, then time series techniques must change models to adapt to new patterns in the data.

Introduction

The toll-free industry has a limited supply of toll-free numbers (TFNs). There are currently five open Numbering Plan Areas (NPAs): 800, 866, 877, 888, and 855. At the end of March 2012, 32,576,390, or 81%, of the available TFN pool was in use, leaving 7,213,703 TFNs in the spare pool. SMS/800, Inc.'s understanding is that the toll-free industry requires approximately 18-24 months of lead time to complete the network changes associated with introducing a new NPA. Accordingly, SMS/800 has an ongoing forecast effort to assess when, or even if, the available numbers will exhaust. The primary objectives of the forecast of Toll-Free Numbers in Use are to: a) estimate when the currently available TFN number pool will exhaust; and, b) assess the risk that the TFN number pool will exhaust over the next one to two years, i.e., the timeframe required for the industry to prepare for a new code.

Prior to the first quarter of 2008, the method used to assess when toll-free number capacity would exhaust was to divide the quantity of spare numbers by the most recent six-week rolling average of weekly number growth. This approach produced weekly results that were highly volatile. The objective of the updated forecast method is to produce a forecast that: (a) does not fluctuate substantially with relatively minor changes in recent values of toll-free number usage; (b) reflects the uncertainty inherent to any forecast by including a range of results and an evaluation of risk of exhaust over time; (c) is based on long-term historical patterns in toll-free number usage rather than short-term perturbations; and (d) is generated by a defensible empirical methodology.

After examining alternative forecasting methodologies, including econometric models, SMS/800, in April 2008, adopted a purely statistical time series forecasting approach. This approach relies on past values of toll-free number use and considers possible changes in the rate of increase over time; it generates toll-free number forecasts as well as measures of the uncertainty surrounding these forecasts at particular decision dates in the future. Rather than relying on a single statistical model, this approach considers multiple statistical models from which the best models are selected.

The TFN forecast here is consistent with, and builds upon, the work performed in previous TFN forecasts, as well as what was learned in the 2009 CRA forecasting methods analysis.[3]

Forecasting Approach and Basic Methodology

SMS/800, Inc. utilized week-ending TFN data available for the period August 23, 1997 through March 31, 2012 (763 weeks). The weekly data was converted to average monthly and quarterly data, end-of-period monthly and quarterly data, and also translated into first differences and natural logs for examination within various statistical models.[4]

[3] In 2009 SMS/800, Inc. performed research related to forecasting methods for the CRA (as well as TFN) and produced the report "CRA Forecasting Methods Analysis".
[4] The data is described in more detail in a separate section.

SMS/800, Inc.'s approach could rely on a strictly new analysis and assume a clean slate each time a TFN forecast is undertaken. This clean slate approach would examine a wide range of statistical and econometric forecasting techniques, would require significantly more calendar and staff time, and would be much more expensive. However, SMS/800, Inc. relies on its experience generally, and specifically its experience with TFN forecasts, to focus the TFN forecasting effort on the techniques and methods that will be most effective. For these reasons, SMS/800, Inc.'s current efforts did not specifically attempt to employ economic data or econometric approaches to forecasting TFNs. SMS/800, Inc.'s approach follows the data. The behavior of the TFN data did not change radically since the last TFN forecast in October 2011, and thus the approach does not change radically, incorporating all that SMS/800, Inc. has learned about this data set over the last several years. As with recent work in both CRA modeling and TFN forecasting, success in using ARIMA models lead SMS/800, Inc. to consider these models again for forecasting TFNs.[5] In addition, our work in March 2010, demonstrated that Autoregressive Conditional Heteroskedasticity (ARCH/GARCH) modeling techniques could be useful to address fluctuations in the variance in the error terms that tend to arise with the use of longer sample periods. SMS/800, Inc. again considered ARCH/GARCH techniques and the use of the full sample of historical data.[6]

It should be noted that statistical time-series methods, while generally sound and defensible, essentially assume that past behavior is a window into the future. They implicitly assume that TFN usage will exhibit essentially the same behavior in the future as it has over the historical period used to estimate the model. If historical TFN usage were increasing rapidly, then the forecast should show continued rapid growth. Alternatively, if historical TFN growth was gradual, then forecasted TFN growth should generally exhibit the same behavior. These statistical techniques are designed to assess the volatility and implicit weighting of past growth patterns in ways that non-statistical techniques cannot. Moreover, these statistical techniques are predicated on assessments of their demonstrated forecast accuracy and can assess the risk associated with announcing or delaying future code openings at specific future dates. Non-statistical techniques offer no such assessments of forecast performance or appraisals of the risk incurred by timely business actions or the consequences of inaction.

The weekly, monthly and quarterly data sets were each bifurcated into an estimation period and a hold-out period. The latter is used for model selection by testing and comparing the forecast accuracy of models calibrated using the same (or even different)

[5] A time series forecasting technique such as ARIMA relies on observations of data at regular time intervals. For the sake of discussion, the illustration in this footnote uses "month" as the time interval of observation. An ARIMA model, summarized by ARIMA (p,d,q), can be characterized by three categories of parameters: **p,** the longest number of months by which past data directly influence current data, also referred to as the autoregressive (AR) term; **d,** the number of times the series (i.e. TFN) is differenced to recognize the degree of increase or decrease over time; and **q,** the longest number of months by which lagged forecast errors improve the prediction of current data. The lagged forecast error **q** term is also referred to as a "moving average" (MA) term; this term is akin to creating an exponentially weighted average of past data (of TFN or its degree of increase or decrease in this instance), with the most recent data given the highest weight and the weights assigned to older data exhibiting exponential decay.

[6] GARCH and ARCH terms, described later.

estimation period(s). Use of at least a two-year hold-out period is preferable since this corresponds to the outer range of lead time for the toll-free industry to implement a new toll-free code.[7]

Various statistical model specifications were estimated with data from the estimation periods.[8] The forecasts from these models were then compared to the actual TFN values for the corresponding common hold-out period. Better performing models were re-estimated with the full sample of data (through March 2012).

The candidate models were assessed on the basis of the following characteristics:

1) statistical significance of the modeled terms;
2) whether the resulting in-sample residuals appeared to be random (i.e., exhibited white noise);
3) the principle of parsimony (the fewest terms employed to still fit the data and produce white noise);
4) forecast errors in the hold-out period (Mean Percent Error (MPE), Mean Absolute Percent Error (MAPE), and Theil's measure of forecast bias);
5) the size of the confidence interval around the estimate;
6) robustness – whether the terms changed or their coefficients changed significantly when the models were re-estimated with the full data set; and,
7) whether the forecasts made sense, based upon our knowledge of TFNs.

As noted above, the business decision facing the SMS/800 is when to start the planning and development effort required to open a new toll-free Numbering Plan Area (NPA). As an extension of the original base forecasting efforts, SMS/800, Inc. has expanded the focus to assess, more explicitly, the risk of exhaust over the relatively near-term (e.g., 2 year) period. These values are more germane to the business decision of starting the process to open a new toll-free NPA. This risk assessment utilizes information about the variance underlying the model forecasts (similar to the information used in creating a confidence interval around an estimate). This is described in more detail in a later section of the report.

[7] Because insufficient time had passed since the 2010 code opening, the fall 2011 forecasting analysis relied on a hold-out period of only 18 months rather than 24 months. Sufficient time has now elapsed to return to a 24-month hold-out sample for the current analysis.

[8] The specific data for the estimation period is determined by the length of the hold-out period. For example, with a 24 month hold-out period and monthly data, the hold out period was April 2010 to March 2012, while the estimation period was September 1997 to March 2010.

The Data Set and Sample Period

Weekly historical data for TFNs in use is available starting in August 1997 through March 2012 (763 weeks in total).[9] A monthly average TFN series (175 months) was created by taking average TFNs in use during each month beginning with September 1997. A monthly end-of-period TFN series was created by taking the last weekly value within each month for the same timeframe as the average series. A quarterly average TFN series (58 observations) was created by taking average TFNs in use during each quarter beginning with fourth quarter 1997. A quarterly end-of-period TFN series (59 quarters) was created by taking the last weekly value within the quarter beginning with third quarter 1997.

In the past, there had been some concern about sufficiency of sample size when using quarterly data. A statistical rule of thumb is to employ samples with 40 or more observations for ARIMA modeling. With a 24-month hold-out sample, the estimation sample when using end-of-period quarterly data is 51 quarters, and there are 59 quarters for the full-sample re-estimation. These samples are sufficiently large for the application of ARIMA analysis.

Statistical examination of the data series reveals a notable characteristic of the TFN series - the variation or fluctuation in TFNs over time.[10] Specifically, the pre-2001 period is characterized by a much larger degree of variation in TFNs than the post-2001 period. Moreover, as seen in the table below, the variation across level data frequencies (i.e., weekly, monthly, quarterly) is essentially the same for each period examined.

		Coefficient of Variation				
		1997Q4 - 2000Q4	**2001Q1 - 2003Q4**	**2004Q1 - 2009Q3**	**2009Q4 - 2012Q1**	**1997Q4 - 2012Q1**
Weekly	**Level**	17.43%	3.51%	4.47%	6.28%	16.39%
Monthly	**Level**	17.50%	3.66%	4.48%	6.33%	16.36%
Quarterly	**Level**	17.78%	3.99%	4.58%	6.45%	16.34%
Weekly	**Difference**	62.45%	-344.56%	407.50%	145.67%	239.79%
Monthly	**Difference**	34.23%	-269.36%	193.92%	90.80%	168.23%
Quarterly	**Difference**	23.62%	-233.77%	111.64%	48.81%	140.50%

In contrast, when the three data series are transformed (from levels) into first differences to reflect TFN's rate of increase or decrease from one period to the next, these conclusions change. As shown in the table above, the degree of variation across the series differs by the periodicity of the data with the longer periodicity exhibiting lower variation (i.e., the first-

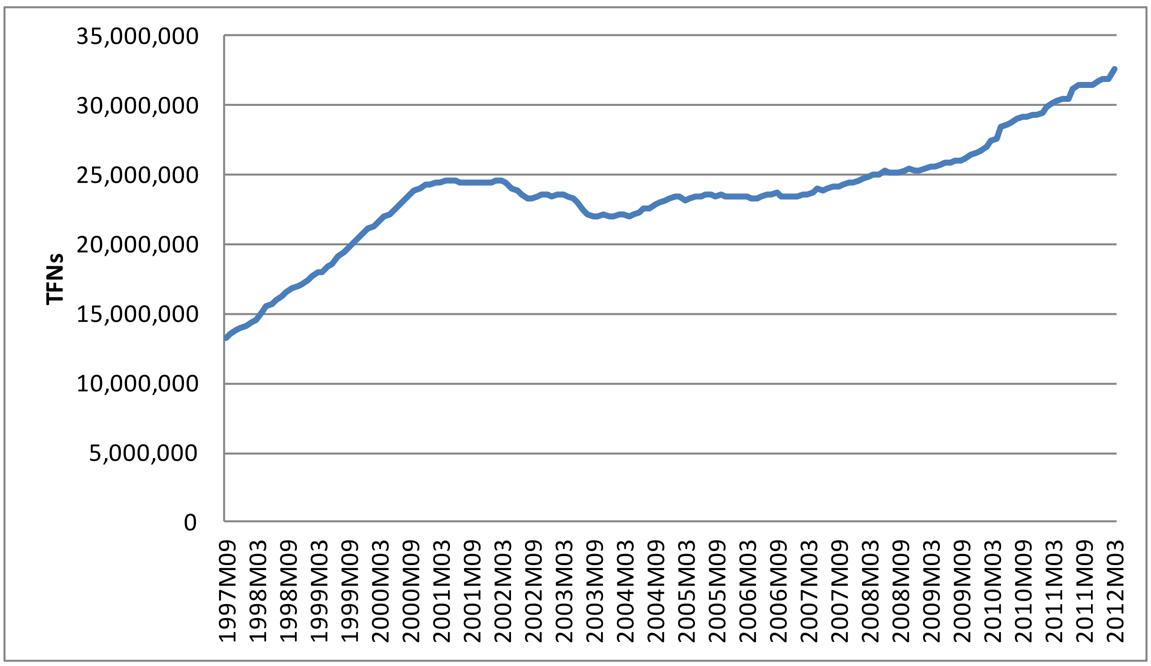
[9] Several "gaps" in the weekly series prior to 2002 were filled in using a simple interpolation method. All data provided were assumed to be accurate. No cleansing of raw data was done to correct potential typos or other errors.

[10] In statistical terms, TFN data are non-stationary, which suggests that it is more appropriate to model rates of change (i.e., first differences) rather than the level of TFN.

differenced quarterly series exhibits the least variation across the full sample, and the first-differenced weekly series exhibits the most variation across the full sample). Thus, models estimating the rate of change in TFNs are likely to perform better using monthly or quarterly data rather than the more volatile weekly data.

Also note that, regardless of the periodicity of the data, the post-2001 period exhibits a much higher degree of variation (in first differences) than the pre-2001 period (opposite of the pattern in the un-differenced, or levels, series). Differenced TFN shows greater variation after 2001, especially during 2001-2003, a period characterized by a general decline in the level of TFNs and several turning points.

One critical question is whether the entire period for which historical data exists is germane to the current forecast for TFN usage. As can be seen from the graph below and the coefficients of variation for first differences in the table above, the rate of growth of TFNs has varied considerably over the past 15 years.



The use of the full sample period, while providing more data, means that first difference models are estimated across a data set in which the coefficient of variation in the data changes significantly across time periods; this has the potential to produce heteroskedasticity in the estimated residuals of the models. To address this issue, (i.e. to improve the statistical efficiency of the long-run forecasts) ARCH/GARCH terms[11] are often

[11] An autoregressive conditional heteroskedasticity (ARCH) modeling term considers the variance of the current error term to be a function of the variances of the previous time periods' error terms. It is employed commonly in modeling financial time series that exhibit time-varying volatility clustering. If an autoregressive moving average model is assumed for the error variance, the model is a generalized autoregressive conditional heteroskedasticity (GARCH). See, e.g., http://en.wikipedia.org/wiki/Autoregressive_conditional_heteroskedasticity.

employed in the modeling process.[12] From work performed in March 2010 and November 2011, SMS/800, Inc. found that the introduction of ARCH/GARCH terms may improve the modeling of TFN time series.

SMS/800, Inc.'s November 2011 analysis formally reexamined the question of whether statistical models using shorter historical TFN samples might produce forecasts superior to models using the full historical sample. Using hold-out tests, the analysis concluded that models using the full historical sample produced superior forecasts. Because recent data show no major changes in pattern from fall 2011, the current analysis accepts the conclusion that the forecasting models should be estimated using the full historical sample of TFN data.

Some accelerations in TFN growth may be caused by well-known documented events. For example, in 1998, 2000, and 2010 SMS/800 opened new toll-free NPAs. In 1998 and 2000, TFNs in use increased dramatically immediately after the code openings as Resp Orgs reserved numbers in the new prefix that were popular in previous prefixes. Prior to the 2010 code opening, the FCC established rules governing access to the new prefix limiting the quantity of TFNs each Resp Org could reserve per day. These rules may have modified the growth in TFNs immediately after the 2010 code opening. Nevertheless, an increase in the rate of TFN growth still occurred, but was less dramatic and spread over a longer adjustment period. To accommodate such causative accelerations in TFN growth, the current analysis introduces indicator variables into the ARIMA models to reflect the opening of new NPAs and the subsequent periods of adjustment in TFN growth[13]. The periods associated with the two earlier code openings in 1998 and 2000 are included in the estimation samples. The period associated with the 2010 code opening is included in the hold-out samples.

Model Estimation and Selection

SMS/800, Inc. examined many ARIMA models with varying data samples and specifications. Differenced data—both with log transformations and without-- were examined for weekly data, monthly and quarterly averaged data, and monthly and quarterly end-of-period data. ARCH and GARCH terms were also examined to assess their ability to improve hold-out performance. Several models had relatively small errors (less than 1% MAPE) for the 24 month hold-out period. Because several of the models produced similar statistical metrics (e.g., small absolute errors and low bias), other criteria guided the model selection process (as listed in the approach and methodology section above).

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[12] GARCH addresses the residual variance in TFN still unexplained after the ARIMA modeling. For example, the weighted lagged squared residual represents "news" about the evolving variance.

[13] The current analysis also examined the possibility of accelerations in TFN growth prior to code openings. Variables to address such accelerations were not uniformly significant and/or helpful to hold-out performance. Hence, these variables are not included in the forecasting models reported here.

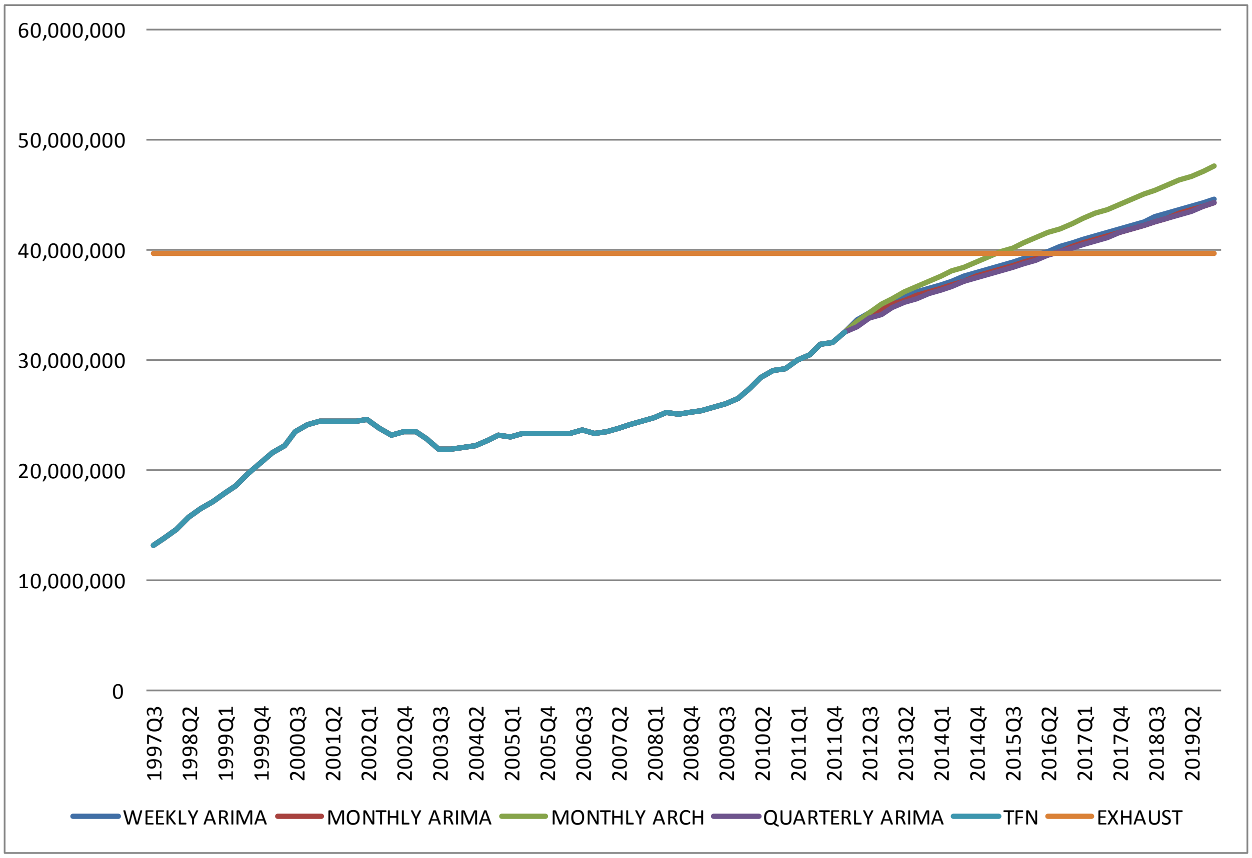
Once the top candidate models had been selected, the models were re-estimated, using the full sample (with data through March 2012). The re-estimated models were evaluated again, adding consideration of robustness of the model terms, their estimated coefficients and the reasonableness of the forecast results.

While several models had acceptable statistical characteristics, the list of candidate models was ultimately narrowed to four "finalists:" one estimated with end-of-period quarterly data, two estimated with end-of-period monthly data and one with weekly data. As guided by the ARIMA modeling process, each of the models utilizes first difference data.

	ARIMA1110Code	ARIMAEOP312Code	ARCHEOP312Code	ARIMAEOP114
Frequency	Week	Month	Month	Quarter
Dep Var (TFN)	Non-Log	Non-Log	Non-Log	Non-Log
Differencing	1x	1x	1x	1x
Constant	Yes	Yes	Yes	Yes
AR Terms	0	1,3	1,3	1
MA Terms	0	2	2	4
ARCH Terms	0	0	1	0
GARCH Terms	0	0	0	0
24-Month MAPE	0.979%	0.989%	0.96%	0.770%
24-Month MPE	0.005%	0.187%	0.143%	0.380%
Exhaust Date	May 2016	August 2016	June 2015	Q3 2016
Date of 20% Risk	Q4 2014	Q4 2014	Q1 2014	Q4 2014

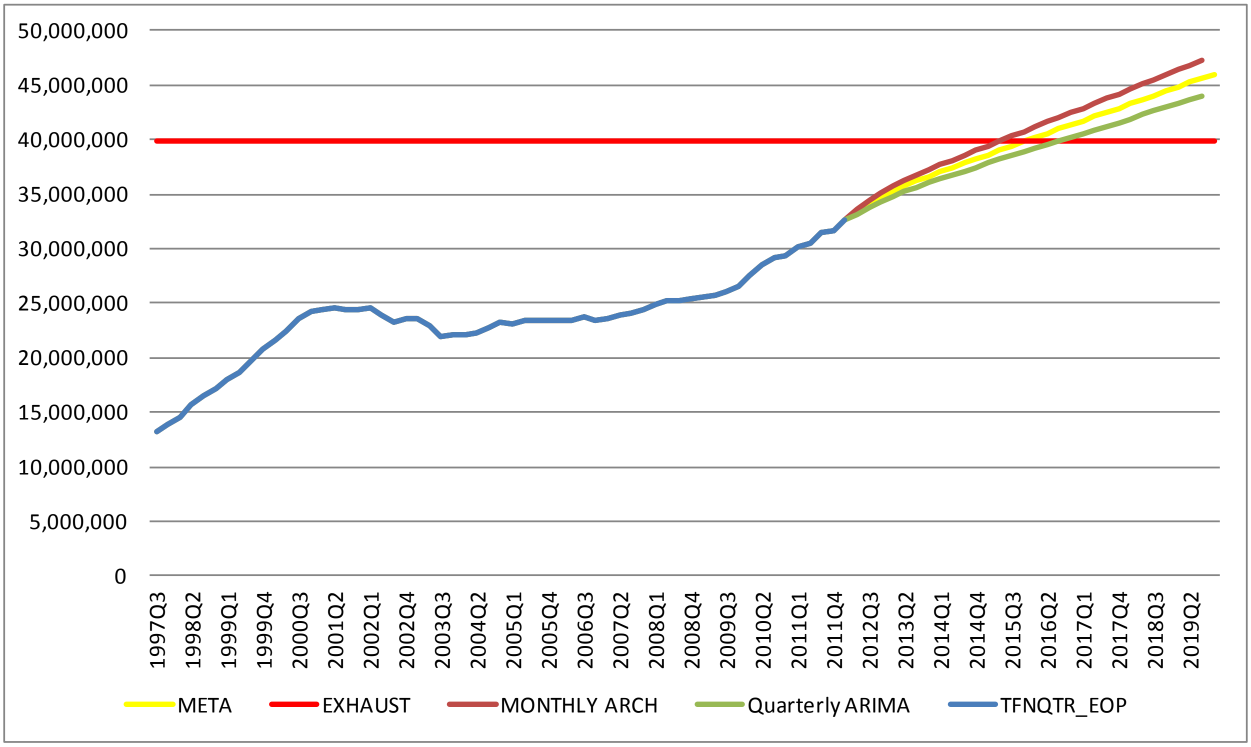
The table above provides a description of the "finalist" models.[14] Note that all of the models have very low mean absolute percentage error (MAPE) for the 24-month holdout period (less than 1%), and low percent bias (MPE). Further, with the exception of the monthly ARCH model, the exhaust dates and risk signatures for the models are very similar. A graph of the forecasts produced by each of the finalist models, below, shows that the Monthly ARCH model (green line) produces a more aggressive forecast.

[14] All of the finalist models, except for the quarterly model, incorporate indicator variables for code openings. For weekly and monthly models, these variables are statistically significant and improve hold-out performance, especially MPE. Such variables were not statistically significant in the quarterly model. While ARCH/GARCH terms were statistically significant in some weekly models, the models did not produce residuals that were white noise. ARCH/GARCH terms were not statistically significant in the best quarterly models.



With the statistical metrics so close, there is little to distinguish among the models, i.e., there is no clear best statistical model. Thus, as SMS/800, Inc. has done in the past, a meta approach, where multiple models are combined, is considered. In a situation where all the models produced very similar forecast results, a meta approach would not produce a different result, i.e., combining models that have the same results will yield that same result. However, in this instance, the ARCH model produces an exhaust date approximately one-year earlier than the other models. A conservative decision-making approach[15], always favored by SMS/800, leads SMS/800, Inc. to include the ARCH model in the meta-model. Although the remaining three models are similar in forecasts and statistical performance, the quarterly model has the best hold-out MAPE and thus was also included in the meta. It would be possible to include all of the models in the meta-model, but SMS/800, Inc. believes that inclusion of more than one of the non-ARCH models would essentially "over-weight" that position. The meta-model reported here averages the forecasts from the monthly ARCH and the quarterly ARIMA models.

[15] A decision-making approach forecasting an earlier exhaust date.



Risk Assessment

As noted above, SMS/800, Inc. augments the point forecasts to assess the risk of exhausting the TFN number pool sooner than the date of the point forecast. These risk values are germane to the business decision of when to start the process to open a new toll-free code.

Specifically risk is defined here as the probability that TFN demand exceeds the stock of TFNs available under existing codes. For example, risk of 25% on a specific date suggests that there is a one in four chance that TFNs will exhaust by that date or 3:1 odds against exhaust. Risk of 50% on a specific date suggests there are even odds that any spare TFNs remain available. This is the most probable date of exhaust. After that date, the odds are higher than 1:1 that TFN demand will exceed the stock of available numbers.

The measure of risk relies upon the measure of the standard error of the forecasts and is conceptually similar to a confidence interval.[16] Based on how the risk is calculated, a measure of risk cannot be developed for the meta-model. Thus, the risk measure for each of the models included in the meta is shown in the table below at quarterly intervals (from second quarter 2013).

[16] Measured as, Risk = 1 – *N ((*Exhaust TFN – Forecast TFN)/Forecast Standard Error) where *N* is the cumulative standard normal distribution.

	Exhaust Risk	
Quarter	**Monthly ARCH**	**Quarterly ARIMA**
2013Q3	12%	1%
2013Q4	19%	4%
2014Q1	25%	8%
2014Q2	31%	13%
2014Q3	37%	18%
2014Q4	42%	23%
2015Q1	46%	27%
2015Q2	51%	32%
2015Q3	55%	36%
2015Q4	58%	40%
2016Q1	61%	44%
2016Q2	64%	47%
2016Q3	67%	51%

Although the ARCH model indicates the most likely date of exhaust is during the second quarter of 2015, nearly three years away, the risk of exhaust rises to 25% within the next two years. The quarterly ARIMA model's risk signature is shifted approximately one-year further out, with the most likely exhaust date more than four years away and the risk of exhaust exceeding 25% within the next three years.

Given that the industry requires at least two years to prepare for the opening of a new code, and assuming that SMS/800 will continue its conservative approach to alerting the industry about potential TFN exhaustion, the risk levels of the ARCH model suggest careful monitoring of TFN demand is warranted.

Some Cautions and Recommendations

The statistical techniques used to develop these projections rely on the historical data and thus cannot predict turning points or dramatic changes in growth that are not implicit in the historical data. Thus, the forecasting exercise that SMS/800, Inc. has performed simply describes the most likely date that toll-free number capacity will be reached *if the data patterns of August 1997 through March 2012 should continue into the future*.

Appendix A – ATIS Approach to Determining an Exhaust Date for the TFN Pool

SMS/800, Inc. believes that statistical analyses, such as those described within the body of this report, are the most appropriate methods for projecting the exhaust of the TFN pool. Further, SMS/800, Inc. believes that statistical methods have the ability to assess risk surrounding the business decisions related to the exhaustion of the TFN pool, e.g., the risk that the TFN pool will exhaust sooner than the point estimate. However, the industry has historically relied on a method developed by ATIS to identify the date at which the industry should be notified of an impending code opening. This approach is described in the "Toll Free Resource Exhaust Relief Planning Guidelines" (ATIS-0300057), published in July 1998.

Exhaust of the TFN pool is determined by inputs for "average demand" and "accelerated demand" to be provided by SMS/800. The prescribed steps to determine the predicted number of months remaining until exhaust are represented by the following formula:

$$\frac{\text{Spares} - (\text{Accelerated Demand} * \text{Quantity of Months of Accelerated Demand})}{\text{Average Demand}}$$

$$+ \text{ Quantity of Months of Accelerated Demand}$$

The approach is appealing in that it is straightforward and simple to implement. However, as the inputs for "average demand" and "accelerated demand" are not well defined, the approach is prone to be arbitrary and can lead to highly volatile results based on different input choices. Further, there may not be an obvious rationale by which to choose among input values. However, it remains SMS/800, Inc.'s understanding that the ATIS approach is the official method for determining when the toll-free industry should be notified of a code opening, and thus a version of the method was examined.

SMS/800, Inc.'s variation on this approach relies upon more narrowly defined inputs, including:

- "Average demand" is defined as the average of all data points (within the sample size selected) within a range of the overall average plus and minus the standard deviation; and,
- "Accelerated demand" is defined as the average of all data points (within the sample size selected) greater than the overall average plus the standard deviation.

For the input related to the number of periods at accelerated demand, rather than simply inputting an arbitrary value, SMS/800, Inc.'s approach calculates how many times historical demand has exceeded the accelerated demand within the sample period. This percentage is then used within the revised formula below:

Spares

(Average Demand * (1- percent of periods above Accelerated Demand/100) + (Accelerated Demand * percent of periods above Accelerated Demand/100))

Examination of many alternatives using the ATIS approach led SMS/800, Inc. to report the following analysis using monthly and quarterly data, and to assess the results for many sample sizes. The tables below for monthly and quarterly samples are demonstrative of the results.

As with many analyses of data sets, the period over which the data is considered has a significant impact on the results. For the purposes of this exercise, SMS/800, Inc. examined the most recent four years of toll free number data, and based the ATIS approach on this data set. The following two tables represent the results based on the analyses performed on months and quarters.

# of Months in Sample	6	12	18	24	36	48
Spares	7,213,703	7,213,703	7,213,703	7,213,703	7,213,703	7,213,703
Average Demand	94,978	120,358	114,738	142,569	147,464	114,632
Accelerated Demand	625,874	624,160	581,155	633,216	588,863	552,946
%-age of periods at Accel demand	17%	17%	17%	17%	14%	13%
Months to Exhaust	39.3	35.3	37.5	32.2	34.6	42.6
Exhaust Date	Jul-15	Mar-15	May-15	Dec-14	Feb-15	Oct-15

Figure A: ATIS Exhaust Approach - Months

# of Quarters in Sample	2	4	8	12	16	20
Spares	7,213,703	7,213,703	7,213,703	7,213,703	7,213,703	7,213,703
Average Demand	550,382	610,311	643,575	557,272	357,210	316,613
Accelerated Demand	1	994,140	1,027,218	1,004,813	969,515	932,851
%-age of periods at Accel demand	0%	25%	25%	25%	25%	25%
Quarters to Exhaust	13.1	10.2	9.8	10.8	14.1	15.3
Exhaust Date	3Q2015	4Q2014	3Q2014	4Q2014	4Q2015	1Q2016

Figure B: ATIS Exhaust Approach - Quarters

As seen in figures A and B above, the ATIS approach indicates exhaust between:

- December 2014 and October 2015 with monthly data; and,
- October 2014 and March 2016 when relying on the quarterly data.